

## Complaints and symptoms among hospital staff in relation to indoor air and the condition and need for repairs in hospital buildings

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**Objectives** The purpose of the study was to determine whether the Indoor Air Questionnaire of the Finnish Institute of Occupational Health works in a hospital environment and whether the questionnaire can be used to determine moisture and mold damage.

**Methods** The Indoor Air Questionnaire of the Finnish Institute of Occupational Health, as modified for hospital environments, was sent to the employees of 10 selected hospitals. At the same time, but separately, a team of experts on building and ventilation technology assessed the condition of the hospital facilities.

**Results** On the whole, hospital staff reported more complaints and symptoms related to indoor air than office workers in a recent control study. More complaints and symptoms related to indoor air were reported in facilities requiring further studies than in facilities that did not require any repairs. The most complaints and symptoms related to indoor air were reported in facilities requiring immediate repairs. In these facilities, the most common complaints were stuffy and dry air, unpleasant odors, the smell of mold or an earthen cellar, dustiness, dirt, and temperature problems. In facilities requiring immediate repairs, the predominant symptoms were headache, irritation of the eyes and nose, irritation of the hands, cough or coughing up phlegm, irritation of facial skin, irritation of head and ears, and irritation of the throat.

**Conclusions** Based on the present study, the Indoor Air Questionnaire would seem to function well also in a hospital environment. Moisture and mold damage requiring immediate repairs can be identified with the help of the questionnaire.

**Key terms** indoor-air questionnaire; mold damage; moisture damage.

The requirements for the quality of indoor air are higher at hospitals than in most other buildings. Good ventilation is necessary to protect the patients, staff, and visitors from hazardous impurities in the indoor air (1). The immune system of some of the patients is deficient, either due to an illness or medical treatments, and thus they are very prone towards contracting infections. Hospital infections cause significant costs (2). In addition to being exposed to microbes, hospital staff is exposed to many chemical agents. They are, among others, anesthesia gases, as well as disinfectants and sterilizing agents. A good indoor-air climate is also a factor related to general well-being because many of the tasks performed in hospitals are very demanding and any mistakes may have very serious consequences.

Moisture and mold problems became one of the most significant occupational health and safety issues in Finland in the 1990s (3, 4). Finnish hospital buildings are old. A significant number of the 20 central hospitals in the Finnish hospital districts were built in the 1950s and 1960s. Water damage is common in Finnish hospital buildings, partially caused by the architecture (flat roofs and many protruding sections). In addition, a lot of water is handled in the hospitals, especially in the patient wards. Many studies have shown that especially deconstruction work significantly contaminates the environment with microbes.

Detecting a mold problem is usually a very complex and expensive process that requires specialized professional skills. Even though the traces of moisture damage

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are clear and there is visible mold growth, these sites are usually not enough to prove that the staff's symptoms are caused by a mold problem in the workplace. Different measurements are needed, the results of which are not always satisfactory to all the parties involved. For example, the results of microbial measurements of the air are often negative even though there is visible mold growth in the building materials (5).

Reaching a consensus on the situation is not always a simple task. Thus it is not possible to respond to the problems fast enough.

Very few studies have been conducted on the health effect of indoor-air problems on the staff and patients in hospitals. Reports have been published on the microbiological risks of renovation work in hospitals. Especially mold spore levels have been found to increase significantly during hospital renovations (6). During repairs *Stachybotrus*, *Aspergillus*, and *Chaetomium* fungi, among others, have been found in hospital washing facilities (7). The appearance of these fungi has been considered a risk concerning certain patient groups, but, for hospital staff, the risk has not been evaluated thus far. A recent study conducted in Finland found that, on the average, hospital staff experience more issues related to work conditions than office workers do, the exception being dust and dirt, which has been found less often in hospitals than in offices (8).

The purpose of this study was to chart the discomfort that hospital staff experienced with respect to indoor-air conditions and related symptoms and to determine how these experiences and symptoms were related to the moisture damage found in the building and what actions were required.

### **Study population and methods**

The hospital project presented in this report was nationwide, and all 20 Finnish hospital districts participated. The technical management of each of the districts was given a survey on the condition of the hospital buildings and the ventilation equipment in these buildings. On the basis of this survey and considering the regional distribution and age of the buildings, the central hospitals of 10 districts were selected for a more in-depth study.

The Indoor Air Questionnaire of the Finnish Institute of Occupational Health (9), which is based on the Örebro indoor climate questionnaire (MM-40) (10), was sent, slightly modified for the staff of the selected hospitals (10) in different departments (5598 forms sent). The forms were sent to the inpatient wards, the outpatient clinics, the laboratories, the staff of the operating rooms, the radiology departments, and the rehabilitation units.

The condition of the hospital buildings was charted by sampling so that, from each of the hospital circuits, one hospital (which could contain more than one hospital building) was selected. A team of experts inspected the condition of the hospital, the team including a construction expert specializing in moisture damage, an occupational hygienist or industrial hygienist, and an expert on ventilation. The team of experts went through the hospital buildings, evaluated the presence of moisture damage, performed the necessary structural studies, and estimated the level and extent of the moisture damage. At the same time, the condition of the hospital ventilation system was estimated, and the possible deficiencies were charted. The questionnaire survey and the assessment of the condition of the hospital facilities were performed separately. Thus the hospital workers did not know of the presence of possible moisture damage while responding to the survey, and, vice versa, the building experts did not know the content of the questionnaire survey when they were examining the premises.

The defining criteria for determining the need for immediate repairs were as follows: (i) criteria for the need for immediate repair; (ii) dampness in the base floor; (iii) contaminated material in the outer walls and the outer wall getting wet because of insufficient protection during renovation; (iv) contaminated material or moisture and mold damage in the inside floor structures; (v) broken water insulation of a balcony; (vi) moisture in structure-damaged floor coatings; (vii) deficient or missing water insulation in bathrooms built using gypsum board structures or cement mosaic plate used in the floor; (viii) smell of dampness on the premises; (ix) leaking roof; (x) water leaks in windows; (xi) water leaking through outside deck structure; (xii) drain leakages and the like; and (xiii) HVAC (heating, ventilation, and air conditioning) systems at the end of their life cycle. The following defining criteria were used for determining the need for further studies in the facilities: (i) need for further investigation; (ii) air-raid shelter lying beneath and dampness problems in the shelter structure; (iii) balcony leaking in separating wall; (iv) condition of bathrooms built using gypsum board structures partly uninvestigated; (v) organic insulation material containing inside-floor structures; (vi) unventilated crawl spaces underneath facilities; (vii) unfinished investigations of damage possibly caused by structural moisture; (viii) leaking skylight and roof; (ix) tracks of leakages in window wall (probably coming from balcony and eave structure) and outer wall structures facing roof; (x) outer walls against earth; and (xi) workers with symptoms in archive premises.

Statistical operations that included chi-square tests, differences in proportions, and logistic regressions were calculated using an SAS program package (version 9.1, SAS Inc, Cary, NC, USA).

## Results

Altogether 3811 employees participated in the survey (return rate 68%). Of these participants, 90.5% were

**Table 1.** Complaints related to indoor air among the hospital workers according to the need for repair on hospital premises. (NS = not significant)

Complaint	No need for repair (a) (N=1789)	Need for further investigations (b) (N=1001)	Immediate need for repair (c) (N=520)	Chi-square test		
				a-b	a-c	b-c
Draft	29	27	29	NS	NS	NS
Room temperature too high	20	23	28	NS	<0.001	0.022
Varying temperature	19	20	27	NS	<0.001	0.002
Room temperature too low	14	15	12	NS	NS	NS
Stuffy air	34	38	59	0.027	<0.001	<0.001
Dry air	43	48	56	0.028	<0.001	0.002
Unpleasant odor	23	25	41	NS	<0.001	<0.001
Static electricity	19	21	14	NS	0.008	<0.001
Environmental tobacco smoke	5	5	4	NS	NS	NS
Noise	31	28	30	NS	NS	NS
Dim light or glare or reflections	19	18	22	NS	NS	0.050
Dust or dirt	11	13	22	NS	<0.001	<0.001
Smell of mold or an earthen cellar	9	13	24	<0.001	<0.001	<0.001

**Table 2.** Symptoms related to the indoor air among hospital workers according to the need of repair on hospital premises. (NS = not significant)

Symptom	No need for repair (a) (N=1789)	Need for further investigations (b) (N=1001)	Immediate need for repair (c) (N=520)	Chi-square test		
				a-b	a-c	b-c
Fatigue	19	24	23	0.006	NS	NS
Headache	7	10	16	0.005	<0.001	0.003
Nausea or dizziness	1	1	2	NS	NS	NS
Difficulties in concentrating	3	4	4	NS	0.041	NS
Fever or chills	1	3	1	0.041	NS	NS
Irritation of the eyes	20	25	32	0.002	<0.001	0.008
Irritated, stuffy or runny nose	23	26	32	0.044	<0.001	0.023
Hoarse, dry throat	16	19	25	0.023	<0.001	0.009
Cough	6	10	13	<0.001	<0.001	NS
Shortness of breath	1	2	2	0.008	0.049	NS
Wheezing of breath	1	1	1	NS	NS	NS
Dry or flushed facial skin	10	14	19	0.003	<0.001	0.010
Scaling or itching scalp or ears	5	6	10	NS	<0.001	0.012
Hands dry, itching, red skin	22	25	29	0.037	<0.001	NS
Muscular and joint pain	8	9	7	NS	NS	NS
Other symptoms	24	37	32	NS	NS	NS

women, and 10.3% were smokers. The most common sources of discomfort were dry air (46% of the participants), stuffy air (40% of the participants), noise (30% of the participants), and draft (27% of the participants). The smell of mold was reported by 12% of the participants.

The most common weekly symptoms attributed to indoor air were irritation of the nose (25% of the participants), irritation of the hands (24% of the participants), irritation of the eyes (23% of the participants), and fatigue (21% of the participants).

Altogether 15% of the total area of the studied hospital buildings was found to need immediate repair. The most immediate need for repair were reported in the patient wards (24% of the studied facilities), whereas the need for immediate repair in other units was less than 10%. The most common causes for immediate repairs were problems in moist facilities, found in 80% of the targeted hospitals. In only two of the hospitals, no structural moisture damage was found in the washing facilities. Other typical problems causing a need for immediate repairs were moisture damage in the foundation structures or intermediate floors and damage in outer walls, which included, for example, contaminated and moist insulation in buildings without a crawl space.

The complaints related to indoor air among the hospital workers according to the need for repair in hospital premises are presented in table 1. Indoor-air problems were more commonly reported in facilities requiring immediate repairs than in other facilities, not including noise, draft, static electricity and low room temperature however. Stuffy and dry air, unpleasant odors, smell of mold or an earthen cellar, a temperature that was too high or varying, and dust and dirt were complained of more commonly in premises with an immediate need for repair than in those with no need for repair. Stuffy air, unpleasant odor, smell of mold or an earthen cellar, dust or dirt, and static electricity were complained of more commonly in premises with an immediate need for repair than in premises with a need for further investigations. The smell of mold or an earthen cellar was reported more often in facilities requiring further studies than in facilities that did not require any repairs (table 1).

The symptoms related to indoor air among the hospital workers are presented in table 2 according to the need for repair on hospital premises. Symptoms were the most commonly reported in facilities requiring immediate repair. The most common symptoms in these facilities were irritation of the eyes, nose, and hands and hoarse, dry throat. Compared with the facilities with no need for repair, those with a need for repair also had workers who more often reported cough, headache, and irritation of facial skin and scalp or ears. In addition, shortness of breath and difficulties in concentrating were

experienced more in the facilities requiring immediate repair. Compared with the facilities with a need for further investigations, those without such a need had more headache and irritation symptoms of mucous membranes or facial skin and scalp. The appearance of cough was the best symptom to use to differentiate between the premises with a need for further investigation from those with no need for repair.

The previous allergic diseases reported by the participants in the survey and those reported by the office workers in a recent control study are presented in table 3. The hospital workers more often reported asthma and allergic rhinitis than the office workers did. In addition, atopic conditions were more common among the hospital staff than among the office workers. On the basis of the need for repair in the facilities, the prevalence of asthma, allergic rhinitis, and atopic eczema seemed to increase as the condition of the facilities decreased, but the difference between the groups was not statistically significant. On the basis of heredity, the situation seemed to be the opposite, but again the difference between the groups was not statistically significant.

Recurrent respiratory infections during the past 12 months were reported by 25.7% of the participants in the survey. This question was not included in the traditional indoor-air questionnaire (MM-40) used in the offices. Grouped according to the need for repair, the facilities differed statistically very significantly ( $P < 0.001$ ). Recurrent infections were reported the least in the facilities with no need for repair (22.8%); however, there were clearly more infections in facilities requiring further studies (28.1%), and the most occurred in the facilities requiring immediate repair (31.2%).

The questions in the section dealing with the psychosocial work environment referred to the content of the work, to the amount of work, to the possibilities to influence one's work, and to the social support at work. Most of the participants in the survey (82%) considered their work as often interesting and stimulating, 21% were often able to influence their work and work conditions, and 78% believed that they received help from their colleagues in problematic work situations (table 4). In the present study, 22% of the respondents estimated their workload as often too great, and 64% estimated that they sometimes had too much work to do.

A heavy workload was reported more often in the facilities requiring immediate repair than in those not requiring repair ( $P < 0.009$ ). The need for immediate repair did not have a connection with the other characteristics in the psychosocial environment (table 4). Logistic regression was used to examine the association between perceived heavy workload and, on the other hand, the need for repair with reported general symptoms (fatigue, headache, difficulties in concentrating). Both factors did have a connection with general symptoms. However, a

**Table 3.** Allergic diseases reported by the hospital and office workers.<sup>a</sup> (NS = not significant)

Allergic disease	Hospitals		Offices		P-value <sup>b</sup>
	Respondents (N)	%	Respondents (N)	%	
Asthma	3730	10.3	10863	7.7	<0.001
Allergic rhinitis	3725	42.0	10872	37.6	<0.001
Atopic eczema	3730	27.5	10872	28.2	NS
Parents or siblings have had above-mentioned diseases	3715	41.4	10825	38.9	0.007
Recurrent respiratory infections during the last 12 months	3709	25.7	–	–	–

<sup>a</sup> Office workers in a recent control study.

<sup>b</sup> The P-value was estimated for the difference in the proportion between the groups.

**Table 4.** Psychosocial work environment according to the need for repair.

Question on psychosocial work environment	Yes, often (%)	Yes, sometimes (%)	No, seldom (%)	No, never (%)	Respondents (N)
Do you regard your work as interesting and stimulating?					
No need for repair	81.7	16.3	1.8	0.3	1766
Immediate need for repair	82.4	16.2	1.2	0.2	518
Do you have too much work to do?					
No need for repair	20.2	64.1	14.8	1.0	1769
Immediate need for repair	25.4	64.0	10.4	0.2	519
Do you have any opportunity to influence your work conditions?					
No need for repair	20.8	50.5	25.5	3.1	1766
Immediate need for repair	20.2	52.3	25.9	1.6	514
Do your fellow workers help you with problems you may have in your work?					
No need for repair	78.9	18.5	2.2	0.3	1769
Immediate need for repair	77.2	18.7	3.7	0.4	518

heavy workload explained fatigue and difficulties in concentrating better than the need for repair (table 5). In relation to headache, the role of perceived workload as a factor was less significant.

## Discussion

This study is the first to test the usability of the indoor air questionnaire in hospitals. The experts in this study evaluated the condition of the workplaces without knowing the results of the study beforehand.

Between 1996 and 2000, mold fungi have become the most common cause of occupational diseases in health care and in social services. According to the occupational health survey conducted by the Finnish Institute of Occupational Health in 2000, 18% of health care professionals reported the smell of mold in their work

**Table 5.** Association of perceived heavy workload and a facility's need for repair with the reported general symptoms (logistic regression).

General symptom	95% Wald	
	Point estimate	Confidence interval
<b>Fatigue</b>		
Need for further investigations versus no need of repair	1.28 <sup>a</sup>	1.05–1.55
Immediate need for repair versus no need for repair	1.13	0.88–1.45
Sometimes too much work versus seldom or never too much work	1.80 <sup>a</sup>	1.31–2.47
Often too much work versus seldom or never too much work	5.15 <sup>a</sup>	3.69–7.20
<b>Headache</b>		
Need for further investigations versus no need for repair	1.43 <sup>a</sup>	1.08–1.89
Immediate need for repair versus no need for repair	2.24 <sup>a</sup>	1.65–3.04
Sometimes too much work versus seldom or never too much work	1.32	0.87–2.02
Often too much work versus seldom or never too much work	2.95 <sup>a</sup>	1.90–4.57
<b>Difficulties concentrating</b>		
Need for further investigations versus no need for repair	1.43	0.91–2.24
Immediate need for repair versus no need for repair	1.47	0.86–2.51
Sometimes too much work versus seldom or never too much work	3.61 <sup>a</sup>	1.12–11.64
Often too much work versus seldom or never too much work	11.74 <sup>a</sup>	3.64–37.86

<sup>a</sup> Statistically significant (P-value<0.05).

environment (11). It is difficult to prove that the staff's symptoms are caused by work conditions because the cause of the health hazard related to moisture and mold problems is not known. The complexity of an indoor-air problem complicates the problem-solving process and the alleviation of the symptoms. After exposure has taken place, it is difficult to find facilities, even in thoroughly repaired buildings, where the symptoms will not be apparent.

More complaints and symptoms were reported in hospitals than in offices in a recent control study (9). Only dust and dirt were reported less in the hospitals. Thus Finnish hospitals are still cleaned well, whereas the standards for cleaning offices have decreased. During past years, surveys on the condition of indoor air in hospitals have been conducted in Sweden. In a survey conducted at 15 hospitals, complaints of dry and stuffy air were more common than in the Finnish study. However, complaints on noise and draft were more common in Finland. Concerning symptoms, irritation of the nose, hands, eyes, and throat, as well as cough and coughing up phlegm, were reported more often in Finnish hospitals than in Swedish ones (Andersson, unpublished material). Is the larger number of symptoms caused by

the fact that there are more women working in hospitals than in offices? In earlier studies, women reported more symptoms related to indoor air than men did. On the other hand, the percentage of smokers in the hospitals was lower than half of that in the offices. Nonsmokers usually report fewer symptoms related to indoor air than smokers do (9). Allergic employees more often report work-related symptoms than nonallergic ones do. The most significant differences concerned nose- and eye-related symptoms, as well as hoarse and dry throat (9). The hospital workers more commonly reported nose and eye symptoms and slightly more commonly reported hoarse, dry throat than the office workers did (8). In our study, hospital employees more often reported previous allergic diseases than office workers did. This finding can explain some of the differences between the hospital facilities and offices with respect to the afore-mentioned symptoms. Between the three subgroups, the allergic diseases did not differ significantly. Therefore, they cannot explain the differences in symptoms between the groups classified according to the different needs of repair.

In the facilities with moisture damage and needing immediate repair, the complaints of dry and stuffy air, unpleasant odors, and the smell of mold or an earthen cellar were emphasized. In addition, a high temperature or a fluctuating temperature, as well as dust and dirt, were reported more often in these facilities.

The number of reported symptoms increased rather evenly from the facilities that required no repair, to those that needed further investigation, to those that required immediate repair. Irritation symptoms were increased in the moisture- and mold-damaged facilities. Most studies have found that the risk of wheezing increases in moisture- and mold-damaged buildings (12–16). Our study could not find a clear difference concerning this particular symptom. Instead, cough and coughing up phlegm were reported more often in the facilities requiring further studies or facilities requiring immediate repair than in the healthy facilities.

When the results of the questions on the psychosocial work environment in hospitals are compared with the material collected in offices (17), it can be seen that hospital staff find their work interesting and stimulating and are of the opinion that they receive good social support more often, than do those working in offices. Instead, the amount of work in hospitals was considered great more often, and the opportunities to influence one's work were fewer than in offices. In the hospital data, the amount of work was considered great, especially in the facilities requiring immediate repair. Most of the facilities requiring immediate repair were situated in the patient wards. In a study on hospital work conditions, it was found that the atmosphere in patient wards is experienced as more hurried than in other wards. This finding may explain

the difference found also in another phase of this study (18). It can also be that the flaws experienced in the work environment disturb the work process and thus cause a more hurried atmosphere. Psychological overload explained the fatigue and concentration problems related to the work environment in the hospital better than the need for repair in the facilities did.

Many studies have shown that the risk for asthma grows in moisture- and mold-damaged buildings (15, 19–23). This study did not find a significant difference in the prevalence of asthma, allergic rhinitis, and atopic eczema. Recurrent respiratory infections were found more often in the facilities that required further studies than in those that did not, as well as more in the facilities requiring immediate repair than in those requiring further studies. Thus this study supports the view that the prevalence of respiratory tract infections increases in moisture- and mold-damaged buildings (21, 24, 25).

The results of this study indicate that the indoor air questionnaire can be used reliably to identify the needs for immediate repair due to moisture and mold damage.

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